

**Toward Establishing a Standard Symptom Set for Assessing Sluggish Cognitive Tempo in
Children: Evidence from Teacher Ratings in a Community Sample**

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Abstract

Despite increasing interest in sluggish cognitive tempo (SCT) in children, the field is stymied by the lack of a standard symptom set that can be used across studies. Without a standard symptom set, it is difficult to determine if differences across studies are due to methodological or sample differences, or simply the way SCT was measured. To move the field toward a standard symptom set, this study evaluates a teacher-report rating scale of SCT revised based on recent meta-analytic findings that identified optimal items for distinguishing SCT from attention-deficit/hyperactivity disorder inattention (ADHD-IN). Participants were 1,349 students (50.7% male) in 2nd-5th grades. Teachers provided ratings of SCT, ADHD-IN, academic impairment, and social impairment. Exploratory structural equation modeling found 15 of the 16 SCT items to demonstrate excellent convergent validity and discriminant validity with ADHD-IN. The measurement properties of the SCT construct were also invariant across sex. SCT was uniquely associated with both academic and social impairment above and beyond ADHD-IN and sex. Although replication and extension is needed, the current study provides the strongest evidence to date of a possible standard symptom set that can be used across studies examining SCT in children.

Key Words: ADHD; assessment; attention; factor analysis; measurement; sluggish cognitive tempo

Toward Establishing a Standard Symptom Set for Assessing Sluggish Cognitive Tempo in Children: Evidence from Teacher Ratings in a Community Sample

There is a compelling body of research demonstrating the distinction between sluggish cognitive tempo (SCT) (e.g., daydreaming, mental ‘fogginess,’ slowed behavior/thinking, lethargy) and attention-deficit/hyperactivity disorder inattention (ADHD-IN) (Becker et al., 2016). In addition, there is increasing evidence that SCT is associated with internalizing symptoms, academic difficulties, and socio-emotional impairments, even after controlling for ADHD symptoms (Barkley, 2014; Becker, 2017; Becker et al., 2016). Many of the recent findings pertaining to the internal and external validity of the SCT construct occurred in tandem with important, much-needed efforts to improve the measurement and assessment of SCT. Until the mid-2000s, SCT was measured with a handful of items that had been somewhat serendipitously included in broadband rating scales of children’s behavior. Although these post-hoc measures of SCT clearly had – and continue to have – merit, systematic psychometric work was clearly needed to improve the assessment of SCT.

Assessing SCT in Children

In 2009, Penny and colleagues (Penny, Waschbusch, Klein, Corkum, & Eskes, 2009) published the first SCT-specific rating scale based on a careful psychometric validation process. Specifically, Penny et al. conducted a review of the literature to identify possible SCT items, and then utilized a group of experts to evaluate the content validity of the 26 identified items. The remaining 14 items were subjected to factor analyses and also examined for reliability in a community sample of children. This study made a major contribution towards improving the assessment of SCT in children, though it also led to some confusion since some items (e.g., *“needs extra time for assignments,” “effort on tasks fades quickly,” “lacks initiative to complete*

work”) were retained as SCT items even though they loaded with ADHD inattentive items in additional factor analyses that included both SCT and ADHD symptoms (Penny et al., 2009). These items were found to again load with ADHD-IN in a subsequent clinical sample of children (Jacobson et al., 2012), indicating that more work was needed to identify those items that best represented the SCT construct as separate from ADHD-IN.

Following the Penny et al. (2009) and Jacobson et al. (2012) studies, researchers began to focus on identifying SCT items that not only represented the SCT construct but were also empirically separable from ADHD-IN items, as well as related constructs such as depression, anxiety, and daytime sleepiness (Barkley, 2013; Becker, Burns, et al., 2017; Becker, Luebbe, Fite, Stoppelbein, & Greening, 2014; Langberg, Becker, Dvorsky, & Luebbe, 2014; Lee, Burns, Snell, & McBurnett, 2014; McBurnett et al., 2014; Willcutt et al., 2014). As evidence of the rapidly growing interest in SCT measurement, three new rating scales for assessing SCT in children were published within a one-year period (Barkley, 2013; Lee et al., 2014; McBurnett et al., 2014). Once again, these rating scales made major contributions to the field but also led to somewhat different conclusions regarding the nature and boundaries of the SCT construct. For instance, research with these three new rating scales concluded that SCT was comprised of one factor (Lee et al., 2014), two factors (Barkley, 2013), or three factors (McBurnett et al., 2014). Furthermore, the three-factor model identified by McBurnett et al. (2014) included a factor comprised of items assessing mental confusion (which the authors termed ‘working memory’) that had not been included in other studies despite these items being historically linked to the SCT construct (Carlson & Mann, 2002; Lahey et al., 1988). Given the differences across these measures of SCT, as well as the post-hoc measures of SCT that continue to be used, a major challenge for SCT research has been the difficulty in comparing findings across studies, which is

of clear import given the increasing interest in SCT and its importance for child development and adjustment. For example, there are mixed findings regarding what, if any, association SCT symptoms have with daily life executive functioning deficits or neuropsychological test performance, yet all studies examining these associations in children have used widely differing measures of SCT (Barkley, 2013; Bauermeister, Barkley, Bauermeister, Martinez, & McBurnett, 2012; Becker & Langberg, 2014; Tamm, Brenner, Bamberger, & Becker, 2016; Wåhlstedt & Bohlin, 2010; Willcutt et al., 2014). A priority for SCT research is establishing a standard symptom set that can be used in both research and clinical contexts.

Given the number of new measures for assessing SCT, as well as a rapid increase in SCT research more generally, a meta-analysis was recently conducted to examine the internal and external validity of the SCT construct (Becker et al., 2016). Becker and colleagues found that 150 items had been used as putative SCT items, which were distilled to 18 core SCT items. Meta-analytic findings indicated that 13 of these 18 potential SCT items consistently loaded on an SCT factor as opposed to an ADHD-IN factor and were therefore deemed to be optimal items for assessing SCT as distinct from ADHD-IN (Becker et al., 2016). However, no existing measure included all 13 optimal SCT items, which made it clear that more measurement work was needed before a standard SCT symptom set could be established.

As SCT research has advanced, the SCT measure by Lee and colleagues (2014) has been used most frequently (Becker et al., 2016). Lee and colleagues used the SCT module of the *Child and Adolescent Disruptive Behavior Inventory* (CADBI) (Burns & Lee, 2010), which was itself based on a clinical interview for assessing SCT in children (McBurnett, 2010). Since its original validation in a community sample of children (Lee et al., 2014), the SCT module of the CADBI has also been validated in clinical samples (Fenollar Cortés, Servera, Becker, & Burns, 2017).

The CADBI SCT measure has also been validated in children (ages 4-14 years) in Asia (Khadka, Burns, & Becker, 2016; Lee, Burns, & Becker, 2016, 2017), Europe (Bernad, Servera, Becker, & Burns, 2016; Burns, Servera, Bernad, Carrillo, & Cardo, 2013; Servera, Bernad, Carrillo, Collado, & Burns, 2016), and South America (Belmar, Servera, Becker, & Burns, 2017). As such, the CADBI SCT measure has demonstrated validity across diverse nationalities, ages, and sample types. Nevertheless, the SCT meta-analysis (Becker et al., 2016) indicated that some items on the CADBI were not optimal for assessing SCT, and likewise, some optimal SCT items were not included on the CABDI.

To further improve the measurement of SCT, the CADBI was revised following the findings of the SCT meta-analysis (Becker et al., 2016). First, the nine CADBI SCT items were evaluated for their (mis)alignment with the 13 items identified in the meta-analysis, with items reworded or added as indicated. In addition, three items assessing mental confusion were added based on preliminary evidence that these items may also be important when assessing SCT and should not be prematurely discarded (McBurnett et al., 2014). This led to a revised set of 16 total SCT items as shown in Table 1. Second, while the CADBI was initially developed to assess DSM-IV disruptive behavior disorder symptoms, the more recent addition of SCT and internalizing modules led to “disruptive” being removed and the measure was more simply named the *Child and Adolescent Behavior Inventory* (CABI; Burns, Lee, Servera, McBurnett, & Becker, 2015a, 2015b). The primary objective of the present study was to evaluate the convergent and discriminant validity of the CABI SCT items.

Sex Differences in SCT

Mixed findings have been reported among studies examining whether boys and girls differ in SCT symptom severity. Although a number of studies found no differences in SCT

scores between boys and girls (Becker et al., 2013; Becker, Garner, Tamm, Antonini, & Epstein, 2017; Becker & Langberg, 2013; Becker, Luebbe, et al., 2014; Bernad, Servera, Grases, Collado, & Burns, 2014; Burns et al., 2013; Garner, Mrug, Hodgins, & Patterson, 2013), other studies have found boys to have higher SCT scores than girls (Becker, 2014; Becker, Luebbe, & Joyce, 2015; Camprodon-Rosanas et al., 2017; Khadka et al., 2016). In synthesizing findings across studies, a recent meta-analysis indicated that boys display slightly more SCT symptoms than girls, though the magnitude of the association was very small and deemed potentially negligible ($r = 0.05$) (Becker et al., 2016). It is clear that additional studies are needed to evaluate whether there are sex differences in SCT.

In addition, previous studies in the United States have shown SCT symptom ratings to have invariant measurement properties across males and females in adults (Becker, Langberg, Luebbe, Dvorsky, & Flannery, 2014) and across boys and girls when parent ratings of SCT were used (Becker, Luebbe, et al., 2014). One study of Spanish children examined invariance across sex when teacher ratings were used (Bernad et al., 2014). The present study examined sex differences as well as measurement invariance across sex when teacher ratings were used to assess SCT in a sample of children from the United States.

External Validity of SCT

It is increasingly clear that SCT is associated with a range of external correlates, including academic and socio-emotional impairments (Becker, 2017; Becker & Barkley, in press; Becker et al., 2016). A growing number of studies demonstrate that SCT remains uniquely associated with academic and social impairment above and beyond ADHD-IN (Bernad et al., 2014; Khadka et al., 2016; Lee et al., 2014; McBurnett et al., 2014; Tamm, Garner, et al., 2016; Willcutt et al., 2014), though exceptions have also been reported (Belmar et al., 2017; Watabe,

Owens, Evans, & Brandt, 2014). Although external validity was not the primary focus of the current study, we expected that SCT would be uniquely associated with global measures of academic and social impairment as a preliminary test of external validity of the CABI SCT scale.

The Present Study

To move the field towards a standard set of SCT symptoms that can be used across studies, the current study uses a large sample of teacher ratings in a community sample to present the first validation of the revised SCT module of the CABI. The primary objective of the present study was to examine the convergent and discriminant validity of the newly-revised CABI SCT items using teacher ratings in a large, community-based sample of children. That is, do the SCT items have substantial loadings on the SCT factor (convergent validity) and substantially higher loadings on the SCT factor than the ADHD-IN factor (discriminant validity)? In addition, this study had three supplemental objectives: (1) to explore whether the CABI SCT items were unidimensional or multidimensional, (2) to examine in invariance analyses whether the SCT symptoms had similar measurement and structural properties across sex, and (3) to evaluate whether SCT was uniquely associated with teacher-rated academic and social impairment above and beyond ADHD-IN.

Method

Participants

Participants included 1,349 students (grades 2 through 5) attending four elementary schools in a large school district in the Midwestern United States. Data were provided by 67 teachers (18 2nd grade teachers, 13 3rd grade teachers, 18 4th grade teachers, and 18 5th grade teachers). As expected in a community sample, there was an equivalent percentage of female (49.3%) and male (50.7%) children. With regards to grade, 26% of the sample were in the 2nd

grade (48.4% female), 17.9% of the sample were in 3rd grade (48.5% female), 27.5% of the sample were in 4th grade (52.6% female), and 28.6% of the sample were in 5th grade (47.4% female). Limited demographic information was available for individual students. However, the racial/ethnic distribution district-wide is 84.5% non-Hispanic White, 6.2% Hispanic, 3.7% Black, 2.3% Asian, 0.2% American Indian/Alaska Native, 0.2% Native Hawaiian/Pacific Islander, and 3.0% multiracial. In addition, 35.8% of students in the district receive free or reduced lunch.

Procedure

Data was collected as part of a larger study, which was approved by the local Institutional Review Board and the school district where data were collected. After obtaining permission from each school's principal, opt-out letters were sent to the 1,651 families of students in the 2nd-5th grades in the four elementary schools participating in this study. The letter stated that the child's school was partnering in a research study to learn more about student behavior in the classroom and its impact on academic, social, and emotional functioning. Families were informed that if they did not opt out of the study, their child's teacher would complete a rating scale assessing their child's concentration as part of the screening for a broader study. The letter explicitly stated that families were not obligated to participate in the screening process, and included instructions to opt-out, with multiple ways of opting-out available (including e-mailing study staff or returning the letter to school with an opt-out box checked). Parents of 76 children (4.6%) opted out of the study. Teachers were also provided a written overview of the study and given the option of not participating; 7 of the 74 2nd-5th grade teachers (teaching 148 students) opted not to participate. Remaining teachers completed a survey via Research Electronic Data Capture (REDCap), which is a secure, web-based application designed to support data capture for research studies (Harris et al., 2009). The survey contained a list of all students listed on the

school's classroom roster at the start of the school year whose parents did not opt out of the study. Two initial questions asked teachers to only complete the survey for each student if the student (1) was still in the classroom, and (2) did not have significant visual, hearing, or speech impairments that were not corrected with assistive devices (e.g., glasses, hearing aids), which further reduced the sample by 59 children. Teachers then completed the SCT, ADHD-IN, and impairment items on the CABI (described below) as well as basic demographic information (i.e., sex, grade) on the remaining participants, though one teacher completed only four of the 23 surveys for students in their classroom, resulting in a final sample size of 1,349 participants. Each teacher rated an average of 20.00 ($SD = 3.59$) children ($Range = 12-28$ students, with the exception of the one teacher who rated 4 students). Teachers were compensated for each survey they completed.

Measure

Child and Adolescent Behavior Inventory (CABI; Burns et al., 2015b). The teachers completed the SCT (16 symptoms), ADHD-IN (9 symptoms), social impairment (2 items; quality of interactions with teachers and peers), and academic impairment (4 items; completion of homework/classwork, reading skills, arithmetic skills, and writing skills) modules of the CABI – Teacher Version. The CABI also includes modules assessing other psychopathology dimensions (e.g., ADHD hyperactivity-impulsivity, oppositional defiant disorder, anxiety, depression), but due to length and teacher burden considerations we were unable to use the full CABI in this study. The SCT and ADHD-IN symptoms were rated on a 6-point scale (*almost never* [*never or about once per month*], *seldom* [*about once per week*], *sometimes* [*several times per week*], *often* [*about once per day*], *very often* [*several times per day*], and *almost always* [*many times per day*]). The social and academic impairment items were rated on a 7-point scale

(i.e., *severe difficulty, moderate difficulty, slight difficulty, average performance [average interactions] for grade level, slightly above average, moderately above average, and excellent performance [excellent interactions] for grade level*). The academic and social impairment items were reverse keyed so higher scores represent higher impairment. Earlier studies provide support for the reliability (internal consistency, test-retest, inter-rater) and validity of scores from the ADHD-IN, social impairment, and academic impairment subscales (Bernad et al., 2016; Bernad et al., 2014; Burns, Becker, Servera, Bernad, & García-Banda, 2017; Khadka et al., 2016; Lee, Burns, Beauchaine, & Becker, 2016; Lee, Burns, & Becker, 2016; Lee et al., 2017). Cronbach's alpha for the ADHD-IN, social impairment, and academic impairment scales in the current study were .97, .92, and .94, respectively. This is the first study to evaluate the reliability and validity of the scores for the new 16 SCT symptoms scale. This scale's reliability is described in the Results section below. The wording of the 16 SCT items are provided in Table 1, and the full CABI measure is available from the corresponding author.

Analytic Approach

Estimation and clustering. The analyses used the Mplus statistical software (Version 7.4) (Muthén & Muthén, 1998-2014). The items were treated as categorical indicators with the use of the robust weighted least squares estimator (WLSMV). Given the children were clustered within teachers, the Mplus type=complex option was used to correct the standard errors.

Criteria for model fit. Global model fit was evaluated with the comparative fit index (CFI, acceptable fit $\geq .90$ and close fit $\geq .95$), Tucker Lewis Index (TLI, acceptable fit $\geq .90$ and close fit $\geq .95$), the root-mean-square error of approximation (RMSEA, acceptable fit $\leq .08$ and close fit $\leq .05$), and the standardized root-mean-square residual (SRMR, acceptable fit $\leq .08$ and close fit $\leq .05$) (Little, 2013). Localized ill fit was also evaluated with an inspection of the residual

correlational matrix (i.e., the number of residuals greater than .10, see (Kline, 2016). These procedures were used to evaluate model fit given the chi-square value is inflated with large sample sizes (Chen, 2007; Little, 2013).

Convergent and discriminant validity of SCT and ADHD-IN symptoms. An exploratory two-factor model was applied to the SCT and ADHD-IN symptoms (this model is also referred to as an exploratory confirmatory factor analysis [ECFA] or exploratory structural equation model [ESEM]) (Asparouhov & Muthén, 2009). Figure 1 shows this model. These analyses allowed the SCT symptoms to cross-load on the ADHD-IN factor and the ADHD-IN symptoms to cross-load on the SCT factor. In line with the SCT meta-analysis (Becker et al., 2016), for an SCT symptom to have convergent validity the loading needed to be greater than .70. For an SCT symptom to have discriminant validity, the cross loading on the ADHD-IN factor had to be less than .30 (a cross-loading close to zero would be ideal). These criteria were used to identify a set of SCT symptoms with convergent and discriminant validity. The same procedure was used to evaluate the ADHD-IN symptoms. The loadings from this analysis are partial standardized regression coefficients because the analysis allows cross-loadings and correlations between the two factors (Brown, 2015, chap. 2). It is possible for such loadings to be larger than 1.00.

Dimensionality of the SCT symptoms. An exploratory factor analysis was applied to the SCT symptoms with convergent and discriminant validity to determine if the SCT dimension was better viewed as a unidimensional or multidimensional construct.

Invariance analyses on SCT and ADHD-IN symptoms across sex. A supplementary analysis was performed to determine the invariance of SCT and ADHD-IN symptom ratings across sex (i.e., the invariance of like-symptom loadings and thresholds across girls and boys).

This analysis also determined if there were significant differences on the SCT and ADHD-IN factor means as a function of sex. The invariance analysis was an exploratory CFA (i.e., the cross-loadings were not restricted to zero) (Asparouhov & Muthén, 2009).

Three procedures were used to evaluate the invariance of like-symptom loadings and thresholds. First, if the decrease in the CFI was less than .01 and the increase in the RMSEA value was less than .015, then the constraints on like-symptom loadings and thresholds were considered tenable (Chen, 2007; Cheung & Rensvold, 2002; Little, 2013). Second, if the model with the constraints on like-symptom loadings and like-symptom thresholds did not result in a significant decrement in fit ($p < .001$), then the results were considered to suggest invariance. The Mplus difftest procedure was used to perform the significant test for the model with and without the constraints. The p -value for this test was set at $p < .001$ given the large size of the sample (Little, 2013). The third procedure inspected the residuals (correlational metric) from the residual matrix to determine if the number of residuals greater than 0.10 increased with the introduction of the constraints on like-symptom loadings and thresholds. If the number of such residuals did not greatly increase with the constraints, then such would indicate a lack of increase in localized ill fit with the introduction of the constraints. If all three procedures suggest invariance, then the like-symptom loadings and thresholds were considered invariant. For invariance analyses with thresholds, it is necessary to constrain the like-symptom loadings and like-symptom thresholds in the same step (Brown, 2015, pp. 353-372).

Unique associations of SCT and ADHD-IN factors with social and academic impairment. An exploratory structural regression model (Asparouhov & Muthén, 2009) was used to determine the unique associations of the SCT and ADHD-IN factors with social and academic impairment (i.e., the social and academic impairment factors were regressed on the

SCT and ADHD-IN factors). This analysis controlled for the effect of the child's sex on the predictors and outcomes. Figure 2 shows this model. This analysis allowed us to determine if higher scores on the SCT factor predicted higher scores on the social impairment and academic impairment factors after controlling for the ADHD-IN factor and the child's sex. An exploratory structure regression model was used because such a model provides a more accurate estimate of the parameters when the cross-loadings on the predictor factors are not zero (Asparouhov & Muthén, 2009). Cross-loadings, however, were not allowed on the outcomes (i.e., the academic and social impairment factors).

Results

Missing Information

The covariance coverage was greater than 99% for all variances and covariances. There was thus little missing information.

Convergent and Discriminant Validity of SCT and ADHD-IN Symptoms

Table 1 shows the loadings (i.e., partial standardized regression coefficients) from the exploratory CFA on the SCT and ADHD-IN symptom ratings. Recall that loadings can be larger than 1.00 with cross-loadings and correlations between factors (Brown, 2015, chap. 2). The “*lacks motivation to complete tasks*” SCT item failed to show convergent and discriminant validity (i.e., a higher loading on the ADHD-IN factor than the SCT factor). The rest of the 15 SCT symptoms showed substantial loadings on the SCT factor (i.e., 0.78 to 1.02) along with low loading on the ADHD-IN factor (i.e., -0.09 to 0.13). These 15 SCT symptoms defined the SCT construct for the subsequent analyses (SCT symptoms in bold in Table 1). Cronbach's alphas for these 15 SCT symptoms was .98. All nine ADHD-IN symptoms also showed strong convergent validity (i.e., 0.77 to 1.08) and discriminant validity (i.e., -0.15 to 0.16).

Model Fit for the 15 SCT and 9 ADHD-IN Symptoms

An exploratory factor analysis was applied to the 15 SCT symptoms with convergent and discriminant validity along with the ADHD-IN symptoms to evaluate the fit of this model. This model yielded a close fit in terms of the CFI, TLI, and SRMR values and an acceptable fit in terms of the RMSEA value, $\chi^2(229) = 1696$, $p < .001$, CFI = .984, TLI = .981, SRMR = .034, and RMSEA = .069 (.066, .072). An inspection of the 276 correlational residuals in the residual matrix found only four greater than .10 (i.e., .103, .104, .109, and .113). These results indicate there was no major localized ill fit (Kline, 2016). The average loading of the 15 SCT symptoms on the SCT factor was 0.89 ($SD = 0.08$, range = 0.77 to 1.05) and .04 ($SD = 0.09$, range = -0.12 to 0.13) on the ADHD-IN factor. For the ADHD symptoms, the average loading of these symptoms on the ADHD factor was 0.90 ($SD = 0.10$, range = 0.78 to 1.07) and 0.04 ($SD = 0.11$, range = -0.13 to 0.17) on the SCT factor. Each of the symptoms thus showed strong convergent and discriminant validity. The correlation between the SCT and ADHD-IN factors was .85 ($SE = .02$). The SCT and ADHD-IN factors thus shared 72% of their true score variance with 28% of the true score variance being unique to each factor.

Dimensionality of the SCT Construct

An exploratory factor analysis was applied to the 15 SCT symptoms to determine if there were multiple SCT factors. The 15 eigenvalues were 12.65, 0.63, 0.42, 0.26, 0.18, 0.16, 0.14, 0.11, 0.11, 0.08, 0.07, 0.06, 0.05, 0.05, and 0.04. These values suggest the 15 SCT symptoms are best represented as a single dimension.

Invariance of SCT and IN Symptoms across Sex

An a priori two-factor model on the 15 SCT symptoms and the ADHD-IN symptoms yielded an acceptable fit across boys and girls, $\chi^2(458) = 2343$, $p < .001$, CFI = .986, TLI = .983,

RMSEA = .078 (.075, .081). An inspection of the 552 residuals (276 for boys and 276 for girls) in the residual matrix (these residuals are in the correlational metric) found only five residuals for girls and four residuals for boys greater than an absolute value of .10 (girls' range: -.105 to -.120, boys' range: -.102 to -.133) (Kline, 2016). Five of these eight residuals involved the SCT symptom *gets mixed up*. This SCT symptom shared indicator specific variance with several similarly worded symptoms (e.g., *easily confused*) which suggests that this item may be somewhat redundant with these other items. There was, however, no major localized ill fit for the baseline model.

An inspection of the unconstrained partial standardized loadings for girls and boys indicated that SCT item 16 (i.e., *difficulty expressing thoughts*) had a substantially different loading for girls (.59) and boys (.93). Given the size of this differences, the loading for this SCT symptom along with its thresholds was not constrained equal across sex. The two-factor model with all the other like-symptom loadings and like-symptom thresholds constrained to be equal resulted in an acceptable fit, $\chi^2(591) = 2113, p < .001$, CFI = .988, TLI = .989, RMSEA = .062 (.059, .065). The WLSMV χ^2 (135) difference test did not result in a p value less than .001, the criteria for this test, χ^2 (133) = 171, $p = .02$. An inspection of the residual matrix for this model indicated no increase in localized ill fit over the baseline model (girls' range: -.10 to -.13 for eight values; boys' range: -.11 to -.13 for two values). The results from these three procedures indicate it was tenable to assume the invariance of like-symptom loading and thresholds across boys and girls with the exception of SCT item 16 (Little, 2013).

Although boys had non-significantly higher scores on the SCT factor than girls (i.e., $M_{\text{difference}} = 0.24, SE = .12, p = .05$, Cohen's latent $d = .21, SE = .12, p = .07$), boys did have significantly higher scores on the ADHD-IN factor than girls (i.e., $M_{\text{difference}} = 0.45, SE = .10, p <$

.001, Cohen's latent $d = .42$, $SE = .11$, $p < .001$). The difference on the ADHD-IN factor represented a medium effect size. The SCT with ADHD-IN factor correlation was .83 ($SE = .02$) and .85 ($SE = .02$) for girls and boys, respectively.¹

Correlations of SCT and ADHD-IN with Social and Academic Impairment

A SCT, ADHD-IN, social impairment, and academic impairment four-factor model yielded an acceptable fit, $\chi^2(377) = 2534$, $p < .001$, CFI = .980, TLI = .977, and RMSEA = .065 (.063, .068). Cross-loadings were allowed between the SCT and ADHD-IN factors but not for any of the other possibilities. The factor correlations for SCT and ADHD-IN with academic impairment were .70 ($SE = .02$) and .76 ($SE = .02$), respectively, with this difference being statistically significant ($p < .001$). The correlations of SCT and ADHD-IN with social impairment were .59 ($SE = .03$) and .55 ($SE = .03$), respectively, with this difference being non-significant ($p = .07$). The academic and social impairment factor correlation was .76 ($SE = .02$) with the SCT with ADHD-IN correlation being .85 ($SE = .02$).

Unique Relationships of SCT and ADHD-IN with Social and Academic Impairment

A structural regression analysis was used to determine the unique associations of the SCT and ADHD-IN factors with the social and academic impairment factors. The analyses controlled for the influence of the child's sex on the two predictors (SCT and ADHD-IN factors) and the two outcomes (social and academic impairment factors).² We report the partial standardized regression coefficients for the unique associations of SCT and ADHD-IN with social and academic impairment while we report the partial semi-standardized regression coefficients for

¹ An invariance analysis across grade (second to fifth) indicated invariance of like-item loadings and thresholds for SCT and ADHD-IN with no significant factor mean differences.

² Grade was not significantly ($ps > .10$) correlated with SCT, ADHD-IN, social impairment, or academic impairment and was therefore not used as a control variable.

sex (i.e., sex was not standardized whereas the two outcome factors, social impairment and academic impairment, were standardized). This model is displayed in Figure 2.

Sex (girls coded 0 and boys coded 1) accounted for 2% of the variance in the SCT factor (i.e., $\beta = .29$, $SE = .05$, $p < .001$) and 5% of the variance in the ADHD-IN factor (i.e., $\beta = .46$, $SE = .05$, $p < .001$).³ Boys had scores .29 and .46 standard deviations higher on the SCT and ADHD-IN factors than girls, respectively. The sex, ADHD-IN, and SCT predictors accounted for 59% ($R^2 = .59$, $SE = .03$, $p < .001$) and 36% ($R^2 = .36$, $SE = .03$, $p < .001$) of the variance in the academic and social impairment factors, respectively. Higher scores on the SCT factor were associated with higher scores on the social impairment (i.e., $\beta = .18$, $SE = .08$, semipartial correlation² [sr^2] = .01, $p = .02$) and academic impairment (i.e., $\beta = .20$, $SE = .05$, $sr^2 = .02$, $p < .001$) factors after controlling for the ADHD-IN factor and sex. Higher scores on the ADHD-IN factor were associated with higher scores on the social impairment (i.e., $\beta = .43$, $SE = .07$, $sr^2 = .05$, $p < .001$) and academic impairment (i.e., $\beta = .61$, $SE = .05$, $sr^2 = .08$, $p < .001$) factors after controlling for the SCT factor and sex. The sr^2 values represent the unique variance accounted for by the SCT and ADHD-IN factors (e.g., SCT accounted for 2% of the variance in academic impairment above and beyond sex and ADHD-IN while ADHD-IN accounted for 8% of the variance in academic impairment above and beyond sex and SCT). The incremental values are small relative to the total variance accounted for due to the high correlation between SCT and ADHD-IN.

While sex was not significantly related to social impairment after controlling for SCT and ADHD-IN (i.e., $\beta = .04$, $SE = .05$, $p > .30$), sex was significantly related to academic impairment

³ The coefficients and d values for sex differ slightly from the values reported from the invariance analysis across sex because in this regression analysis the like-item loadings and thresholds are not constrained equal across sex.

after controlling for SCT and ADHD-IN (i.e., $\beta = -.14$, $SE = .04$, $sr^2 = .01$, $p < .001$). Boys thus had scores .14 standard deviations lower than girls on the academic impairment factor.

Descriptive Information on the Measures

To facilitate the comparison of mean scores using this measure in future studies, Table 2 shows the descriptive information on the SCT, ADHD-IN, social impairment, and academic impairment measures as manifest variables. The means for SCT and ADHD-IN are on the 0- to 5-point scale with the means for social impairment and academic impairment on the 0- to 6-point scale (reverse keyed).

Discussion

There is increasing interest in SCT in children, and yet the field is stymied by the lack of a standard symptom set that can be used across studies (Becker et al., 2016). The current study provides the strongest evidence to date of a possible standard symptoms set that can be used across studies examining SCT in children.

Convergent Validity, Discriminant Validity, and Invariance of SCT

We found 15 of the 16 SCT items on the revised CABI teacher rating scale to demonstrate excellent convergent and discriminant validity. That is, these 15 items loaded strongly together on an SCT factor and did not load with an ADHD-IN factor. Indeed, these 15 SCT items demonstrated very low loadings (i.e., $-.12$ to $.13$) on the ADHD-IN factor. This study is the first direct evaluation of the set of SCT items deemed to be optimal for distinguishing SCT from ADHD-IN in a recent meta-analysis (Becker et al., 2016). Only one of the items (“*Lacks motivation to complete tasks [e.g., apathetic]*”) identified as optimal in the meta-analysis failed to demonstrate convergent and discriminant in the present study. Of note, of the optimal items identified in the SCT meta-analysis, the motivation/apathy item had been examined in the fewest

number of studies and had the weakest overall loading on an SCT factor across all raters (as well as for teacher ratings specifically) (see Table 3 in Becker et al., 2016). The findings from this study call into question the use of a motivation/apathy item for assessing SCT, though future studies will certainly be needed before drawing a firm conclusion regarding this item.

Findings from this study make a major advance in the empirically-based assessment of SCT in children. Although much progress has been made in recent years towards the assessment of SCT, the assessment approach continues to be based on subjective behavioral signs and symptoms. This is consistent with the assessment methods for most other psychopathologies, and SCT has been studied far less than other psychopathology domains such as ADHD, depression, or anxiety. Nevertheless, the study and assessment of SCT are advancing at the same time that the broader field of mental health is seeking to identify objective, often biologically-based, markers of psychopathology. Perhaps the clearest example of this is the National Institute of Mental Health (NIMH) Research Domain Criteria (RDoC) initiative, which, among other things, “assumes that data from genetics and clinical neuroscience will yield biosignatures that will augment clinical symptoms and signs for clinical management” (Insel et al., 2010). It is thus interesting to consider how the assessment (and treatment) of SCT might be furthered through both theoretical and neurobiological advancements. That is, as the study of SCT continues to advance, it is possible that the optimal symptom set will be further refined based on theory and empirical evidence across units of analysis (e.g., genetics, brain networks, physiology). Such refinements should further advance our understanding of the distinctions – and associations – between SCT and other psychopathologies, as well as whether there are meaningful subdimensions of the SCT construct.

Unidimensional vs. Multidimensional Nature of SCT

Another key finding from this study is the empirical support for conceptualizing and assessing SCT as a unidimensional as opposed to a multidimensional construct. The unidimensionality vs. multidimensionality of SCT has been an ongoing question in the field, with previous studies frequently drawing differing conclusions when parent and/or teacher ratings are used (Barkley, 2013; Fenollar Cortés et al., 2017; Lee et al., 2014; McBurnett et al., 2014; Penny et al., 2009). Recently, studies using bi-factor modeling techniques have suggested that specific SCT factors may be less reliable than a general, overarching SCT construct (Becker et al., 2015; Smith et al., 2016). These findings suggest that SCT may be best conceptualized as unidimensional, though as noted by Smith et al. (2016), bi-factor modeling also supports a general ADHD factor and yet the specific inattention and hyperactive-impulsive dimensions predict different aspects of functioning and are clinically meaningful. In line with this latter possibility, some studies have found separate SCT dimensions to differentially relate to functional outcomes (Barkley, 2013; Fenollar Cortés et al., 2017; Langberg, Becker, & Dvorsky, 2014; Tamm, Garner, et al., 2016). However, if a specific factor does not contain a meaningful amount of true score variance independent of the general factor, the ultimate utility of the specific factors is questionable (Arias, Ponce, & Núñez, 2016; Lee, Burns, Beauchaine, et al., 2016).

So where do we go from here in terms of the validity and utility of SCT as either unidimensional or multidimensional? Given the importance of establishing whether SCT is best conceptualized as unidimensional or multidimensional, it would be premature to conclude that SCT is unidimensional based solely on the results of the current study. Nevertheless, our findings do point to some key ways in which future research can further address this issue. Perhaps most clearly, studies seeking to examine a possible multidimensional structure of SCT, as well as

whether SCT dimensions differentially relate to functioning, should first start with an SCT item set that is well-supported by the literature. If the overarching construct of SCT is not well-measured, conclusions regarding unidimensionality or multidimensionality cannot be made since evidence of multidimensionality may simply be an artifact of including non-optimal SCT items. Aside from the measure reported in this study, none of the previously-existing SCT measures have included all of the items deemed optimal for assessing SCT in the meta-analysis (Becker et al., 2016). Perhaps more problematically, previous SCT measures also included some items that were not found to be optimal for assessing the SCT construct as distinct from ADHD-IN. The clearest example of this is the Slow factor from the Penny et al. (2009) measure, which includes items assessing initiative and task effort that have not shown discriminant validity from ADHD-IN symptoms (Becker et al., 2016; Jacobson et al., 2012; Penny et al., 2009). Using measures based on the SCT meta-analysis, such as the CABI used in this study, is a good starting point to ensure that optimal SCT items are being used. Another option, particularly for studies with data collection already underway using other existing measures, is to select only those SCT items with established validity for analyses (Becker, Garner, et al., 2017). Studies that use SCT items that have strong empirical support will be best-suited for further evaluating whether SCT is unidimensional or multidimensional, as well as whether differences exist across raters or whether any identified dimensions have different etiologies and external correlates.

Sex Differences and Measurement Invariance

In addition to identifying 15 SCT items that demonstrated convergent and discriminant validity, we also found 14 of the 15 SCT items to have invariant loadings and thresholds across sex indicating measurement equivalence across boys and girls (SCT item *difficulty expressing thoughts* had a significantly lower loading for girls than for boys). Previous studies have shown

SCT symptom ratings to have invariant measurement properties across males and females in adults (Becker, Langberg, et al., 2014) and across boys and girls when parent ratings of SCT were used (Becker, Luebke, et al., 2014). We extend the findings of Bernad et al. (Bernad et al., 2014) in a Spanish sample of children and demonstrate in measurement invariance between boys and girls in a community sample of children from the United States. In addition, while a meta-analysis indicated that boys display slightly more SCT symptoms than girls (Becker et al., 2016), this effect in the current study was notably small ($d = .21$, $SE = .12$, $p = .07$). The current study did show, however, that boys display significantly more ADHD-IN symptoms than girls ($d = .42$, $SE = .11$, $p < .001$). The sex difference for ADHD-IN was larger than for SCT. Most importantly, however, the invariance of the SCT and ADHD-IN item loadings and thresholds across sex indicates that the measure has similar psychometric properties for boys and girls so that comparisons of latent factor means are meaningful.

External Validity of SCT

A growing body of research demonstrates an association between SCT and a range of functioning domains (Becker, 2017; Becker & Barkley, in press; Becker et al., 2016). Given the screening design of the present study, we were only able to include brief, general measures of impairment. As in previous research, SCT symptoms were significantly associated with both academic and social impairment, above and beyond ADHD-IN symptoms. However, it is important to note that the unique variance in social and academic impairment accounted for by either SCT or ADHD-IN was small. It is unclear if these small incremental effects are clinically meaningful, and this is an important area for further investigation. Likewise, it will be crucial for future studies using the CABI SCT items to examine specific and nuanced aspects of socio-emotional and academic functioning. For instance, SCT is uniquely associated with increased

emotion dysregulation, loneliness, and withdrawal/isolation in children (Becker, Garner, et al., 2017; Becker et al., 2015; Marshall, Evans, Eiraldi, Becker, & Power, 2014; Willcutt et al., 2014). Although results are somewhat more mixed for academic functioning, studies using more recently developed measures of SCT have found SCT to be associated with poorer organizational and study skills, as well as lower grades (Flannery, Luebbe, & Becker, 2016; Langberg, Becker, & Dvorsky, 2014; Willcutt et al., 2014). Findings from the present study provide very preliminary evidence of criterion validity for our revised SCT measure and point to the need for further validation in research using a multi-method, multi-informant design.

Limitations and Future Directions

Strengths of this study include a large sample size, careful selection of SCT items, and rigorous analytic plan. Nevertheless, the study findings should be considered in light of a number of limitations. First, this study only included teacher ratings. Clearly, future studies are needed to evaluate a parallel parent version of the SCT measure examined herein, as well as examining the revised measure in relation to a wide range of adjustment and impairment domains. In addition, the current study included children in 2nd-5th grades from a single (albeit large) school district in the United States, and while race/ethnicity information was not available for individual students most students in the district were non-Hispanic White. It will be important for future studies to examine this SCT measure in diverse nationalities and populations (including clinical samples), as well as in younger children and adolescents. This latter point is especially true since there is emerging evidence that SCT symptoms increase across the transition from childhood to adolescence (Leopold et al., 2016). Finally, given the necessary brevity of the teacher measure used in this study, we were unable to assess anxiety, depression, or daytime sleepiness. Several studies have shown SCT symptoms to be distinct from ADHD-IN as well as internalizing

symptoms and daytime sleepiness (Becker, Luebke, et al., 2014; Becker et al., 2015; Langberg, Becker, Dvorsky, et al., 2014; Lee et al., 2014; Willcutt et al., 2014), but further evaluation of the SCT construct as distinct from, or overlapping with, internalizing symptoms and sleepiness are warranted, particularly as a standard symptom set continues to emerge.

Another limitation of the study was the high number ($M = 20.00$) of children rated by each teacher in this study in comparison to other studies examining SCT with teacher ratings on the CADBI (three to ten students) (Belmar et al., 2017; Khadka et al., 2016; Lee, Burns, & Becker, 2016; Lee et al., 2014). The large number of students rated by each teacher in the present study may have inflated the (1) correlations among the symptoms, (2) Cronbach's alphas, and (3) the factor correlations. For example, in the studies by Belmar et al. (2017) and Lee et al. (2014, 2016), each teacher rated from three to eight students with the factor correlations for SCT and ADHD-IN ranging from .74 to .79. However, in the study by Khadka et al. (2016), each teacher was restricted to rating only six students and the SCT with ADHD-IN factor correlation was .86. In addition, to more directly examine the possible impact of teachers rating a large number of students in our study, we performed an invariance analysis across the first five students rated by each teacher and the last five students rated by each teacher.⁴ We found that the results were the same for the first five and last five children rated by each teacher (i.e., same factor correlations, alphas, and no mean differences) and the same as the total sample. In addition, the high alpha coefficients in the present study may be due to the larger number of SCT items in this study as compared to other studies using the CADBI (which used three to nine SCT items), as well as the possible redundant nature of some of the items (e.g., "*easily confused*" and "*gets mixed up*"). Nevertheless, an ideal future study could restrict each teacher to rating a single student to allow a

⁴ We thank an anonymous reviewer for suggesting this invariance analysis between the first five students and last five students rated by each teacher.

more direct comparison to parent ratings. In any event, the critical issue here is that the 15 SCT symptoms all had trivial loadings on the ADHD-IN factor with the 9 ADHD-IN symptoms also having trivial loadings on the SCT factor, thus indicating excellent discriminant validity at the symptom level.

Conclusion

The findings using the revised SCT measure examined in this study, based on meta-analytic results of optimal SCT items for distinguishing SCT from ADHD-IN, constitute a major step in moving the field towards a standard symptom set for assessing SCT across studies. We found 15 SCT items to demonstrate excellent convergent and discriminant validity from ADHD-IN. In addition, the 15 SCT items were best conceptualized as unidimensional and the measurement properties of the SCT construct were invariant across sex. The present study also provides preliminary evidence of criterion validity of this teacher-report measure of SCT. More research is needed to further evaluate this measure, as well as a parallel parent-report version, in an effort to further move the field towards a standard symptom set for assessing SCT in children.

References

- Arias, V. B., Ponce, F. P., & Núñez, D. E. (2016). Bifactor models of attention-deficit/hyperactivity disorder (ADHD): An evaluation of three necessary but underused psychometric indexes. *Assessment*. Advance online publication. doi:10.1177/1073191116679260
- Asparouhov, T., & Muthén, B. (2009). Exploratory structural equation modeling. *Structural Equation Modeling-a Multidisciplinary Journal*, 16, 397-438. doi:10.1080/10705510903008204
- Barkley, R. A. (2013). Distinguishing sluggish cognitive tempo from ADHD in children and adolescents: Executive functioning, impairment, and comorbidity. *Journal of Clinical Child and Adolescent Psychology*, 42, 161-173. doi:10.1080/15374416.2012.734259
- Barkley, R. A. (2014). Sluggish cognitive tempo (concentration deficit disorder?): Current status, future directions, and a plea to change the name. *Journal of Abnormal Child Psychology*, 42, 117-125. doi:10.1007/s10802-013-9824-y
- Bauermeister, J. J., Barkley, R. A., Bauermeister, J. A., Martinez, J. V., & McBurnett, K. (2012). Validity of the sluggish cognitive tempo, inattention, and hyperactivity symptom dimensions: neuropsychological and psychosocial correlates. *Journal of Abnormal Child Psychology*, 40, 683-697. doi:10.1007/s10802-011-9602-7
- Becker, S. P. (2014). Sluggish cognitive tempo and peer functioning in school-aged children: a six-month longitudinal study. *Psychiatry Research*, 217, 72-78. doi:10.1016/j.psychres.2014.02.007

- Becker, S. P. (2017). "For some reason I find it hard to work quickly": Introduction to the Special Issue on sluggish cognitive tempo. *Journal of Attention Disorders*, 21, 615-622. doi:10.1177/1087054717692882
- Becker, S. P., & Barkley, R. A. (in press). Sluggish cognitive tempo. In T. Banaschewski, D. Coghill, & A. Zuddas (Eds.), *Oxford textbook of attention deficit hyperactivity disorder*. Oxford, England: Oxford University Press.
- Becker, S. P., Burns, G. L., Garner, A. A., Jarrett, M. A., Luebbe, A. M., Epstein, J. N., & Willcutt, E. G. (2017). Sluggish cognitive tempo in adults: Psychometric validation of the Adult Concentration Inventory. *Psychological Assessment*. Advance online publication. doi:10.1037/pas0000476
- Becker, S. P., Fite, P. J., Garner, A. A., Greening, L., Stoppelbein, L., & Luebbe, A. M. (2013). Reward and punishment sensitivity are differentially associated with ADHD and sluggish cognitive tempo symptoms in children. *Journal of Research in Personality*, 47, 719-727. doi:10.1016/j.jrp.2013.07.001
- Becker, S. P., Garner, A. A., Tamm, L., Antonini, T. N., & Epstein, J. N. (2017). Honing in on the social difficulties associated with sluggish cognitive tempo in children: Withdrawal, peer ignoring, and low engagement. *Journal of Clinical Child and Adolescent Psychology*. Advance online publication. doi:10.1080/15374416.2017.1286595
- Becker, S. P., & Langberg, J. M. (2013). Sluggish cognitive tempo among young adolescents with ADHD: Relations to mental health, academic, and social functioning. *Journal of Attention Disorders*, 17, 681-689. doi:10.1177/1087054711435411
- Becker, S. P., & Langberg, J. M. (2014). Attention-deficit/hyperactivity disorder and sluggish cognitive tempo dimensions in relation to executive functioning in adolescents with

- ADHD. *Child Psychiatry and Human Development*, 45, 1-11. doi:10.1007/s10578-013-0372-z
- Becker, S. P., Langberg, J. M., Luebbe, A. M., Dvorsky, M. R., & Flannery, A. J. (2014). Sluggish cognitive tempo is associated with academic functioning and internalizing symptoms in college students with and without attention-deficit/hyperactivity disorder. *Journal of Clinical Psychology*, 70, 388-403. doi:10.1002/jclp.22046
- Becker, S. P., Leopold, D. R., Burns, G. L., Jarrett, M. A., Langberg, J. M., Marshall, S. A., . . . Willcutt, E. G. (2016). The internal, external, and diagnostic validity of sluggish cognitive tempo: A meta-analysis and critical review. *Journal of the American Academy of Child and Adolescent Psychiatry*, 55, 163-178. doi:10.1016/j.jaac.2015.12.006
- Becker, S. P., Luebbe, A. M., Fite, P. J., Stoppelbein, L., & Greening, L. (2014). Sluggish cognitive tempo in psychiatrically hospitalized children: Factor structure and relations to internalizing symptoms, social problems, and observed behavioral dysregulation. *Journal of Abnormal Child Psychology*, 42, 49-62. doi:10.1007/s10802-013-9719-y
- Becker, S. P., Luebbe, A. M., & Joyce, A. M. (2015). The Child Concentration Inventory (CCI): Initial validation of a child self-report measure of sluggish cognitive tempo. *Psychological Assessment*, 27, 1037-1052. doi:10.1037/pas0000083
- Belmar, M., Servera, M., Becker, S. P., & Burns, G. L. (2017). Validity of sluggish cognitive tempo in South America: An initial examination using mother and teacher ratings of Chilean children. *Journal of Attention Disorders*, 21, 667-672. doi:10.1177/1087054715597470
- Bernad, M. D., Servera, M., Becker, S. P., & Burns, G. L. (2016). Sluggish cognitive tempo and ADHD inattention as predictors of externalizing, internalizing, and impairment domains:

- A 2-year longitudinal study. *Journal of Abnormal Child Psychology*, 44, 771-785.
doi:10.1007/s10802-015-0066-z
- Bernad, M. D., Servera, M., Grases, G., Collado, S., & Burns, G. L. (2014). A cross-sectional and longitudinal investigation of the external correlates of sluggish cognitive tempo and ADHD-inattention symptoms dimensions. *Journal of Abnormal Child Psychology*, 42, 1225-1236. doi:10.1007/s10802-014-9866-9
- Brown, T. A. (2015). *Confirmatory factor analysis for applied research* (2nd Ed.). New York: Guilford.
- Burns, G. L., Becker, S. P., Servera, M., Bernad, M. D., & García-Banda, G. (2017). Sluggish cognitive tempo and attention-deficit/hyperactivity disorder (ADHD) inattention in the home and school contexts: Parent and teacher invariance and cross-setting validity. *Psychological Assessment*, 29, 209-220. doi:10.1037/pas0000325
- Burns, G. L., & Lee, S. (2010). *Child and Adolescent Disruptive Behavior Inventory - Version 5.0*. Pullman, WA: Author.
- Burns, G. L., Lee, S., Servera, M., McBurnett, K., & Becker, S. P. (2015a). *Child and Adolescent Behavior Inventory - Parent Version 1.0*. Pullman, WA: Author.
- Burns, G. L., Lee, S., Servera, M., McBurnett, K., & Becker, S. P. (2015b). *Child and Adolescent Behavior Inventory - Teacher Version 1.0*. Pullman, WA: Author.
- Burns, G. L., Servera, M., Bernad, M. D., Carrillo, J. M., & Cardo, E. (2013). Distinctions between sluggish cognitive tempo, ADHD-IN, and depression symptom dimensions in Spanish first-grade children. *Journal of Clinical Child and Adolescent Psychology*, 42, 796-808. doi:10.1080/15374416.2013.838771

- Camprodon-Rosanas, E., Ribas-Fito, N., Batlle-Vila, S., Persavento, C., Alvarez-Pedrerol, M., Sunyer, J., & Forns, J. (2017). Sluggish cognitive tempo: Sociodemographic, behavioral, and clinical characteristics in a population of Catalan school children. *Journal of Attention Disorders, 21*, 632-641. doi:10.1177/1087054716652477
- Carlson, C. L., & Mann, M. (2002). Sluggish cognitive tempo predicts a different pattern of impairment in the attention deficit hyperactivity disorder, predominantly inattentive type. *Journal of Clinical Child and Adolescent Psychology, 31*, 123-129. doi:10.1207/S15374424JCCP3101_14
- Chen, F. F. (2007). Sensitivity of goodness of fit indexes to lack of measurement invariance. *Structural Equation Modeling-a Multidisciplinary Journal, 14*, 464-504.
- Cheung, G. W., & Rensvold, R. B. (2002). Evaluating goodness-of-fit indexes for testing measurement invariance. *Structural Equation Modeling, 9*, 233-255. doi:10.1207/S15328007sem0902_5
- Fenollar Cortés, J., Servera, M., Becker, S. P., & Burns, G. L. (2017). External validity of ADHD inattention and sluggish cognitive tempo dimensions in Spanish children with ADHD. *Journal of Attention Disorders, 21*, 655-666. doi:10.1177/1087054714548033
- Flannery, A. J., Luebke, A. M., & Becker, S. P. (2016). Sluggish cognitive tempo is associated with poorer study skills, more executive functioning deficits, and greater impairment in college students. *Journal of Clinical Psychology*. Advance online publication. doi:10.1002/jclp.22406
- Garner, A. A., Mrug, S., Hodgins, B., & Patterson, C. (2013). Do symptoms of sluggish cognitive tempo in children with ADHD symptoms represent comorbid internalizing

difficulties? *Journal of Attention Disorders*, 17, 510-518.

doi:10.1177/1087054711431456

Harris, P. A., Taylor, R., Thielke, R., Payne, J., Gonzalez, N., & Conde, J. G. (2009). Research electronic data capture (REDCap) - A metadata-driven methodology and workflow process for providing translational research informatics support. *Journal of Biomedical Informatics*, 42, 377-381. doi:10.1016/j.jbi.2008.08.010

Insel, T., Cuthbert, B., Garvey, M., Heinssen, R., Pine, D. S., Quinn, K., . . . Wang, P. (2010). Research domain criteria (RDoC): Toward a new classification framework for research on mental disorders. *American Journal of Psychiatry*, 167, 748-751. doi:10.1176/appi.ajp.2010.09091379

Jacobson, L. A., Murphy-Bowman, S. C., Pritchard, A. E., Tart-Zelvin, A., Zabel, T. A., & Mahone, E. M. (2012). Factor structure of a sluggish cognitive tempo scale in clinically-referred children. *Journal of Abnormal Child Psychology*, 40, 1327-1337. doi:10.1007/s10802-012-9643-6

Khadka, G., Burns, G. L., & Becker, S. P. (2016). Internal and external validity of sluggish cognitive tempo and ADHD inattention dimensions with teacher ratings of Nepali children. *Journal of Psychopathology and Behavioral Assessment*, 38, 433-442. doi:10.1007/s10862-015-9534-6

Kline, R. B. (2016). *Principles and practice of structural equation modeling* (4th ed.). New York: Guilford.

Lahey, B. B., Pelham, W. E., Schaughency, E. A., Atkins, M. S., Murphy, H. A., Hynd, G., . . . Lorys-Vernon, A. (1988). Dimensions and types of attention deficit disorder. *Journal of*

the American Academy of Child and Adolescent Psychiatry, 27, 330-335.

doi:10.1097/00004583-198805000-00011

Langberg, J. M., Becker, S. P., & Dvorsky, M. R. (2014). The association between sluggish cognitive tempo and academic functioning in youth with attention-deficit/hyperactivity disorder (ADHD). *Journal of Abnormal Child Psychology*, 42, 91-103.

doi:10.1007/s10802-013-9722-3

Langberg, J. M., Becker, S. P., Dvorsky, M. R., & Luebke, A. M. (2014). Are sluggish cognitive tempo and daytime sleepiness distinct constructs? *Psychological Assessment*, 26, 586-597. doi:10.1037/a0036276

Lee, S., Burns, G. L., Beauchaine, T. P., & Becker, S. P. (2016). Bifactor latent structure of attention-deficit/hyperactivity disorder (ADHD)/oppositional defiant disorder (ODD) symptoms and first-order latent structure of sluggish cognitive tempo symptoms.

Psychological Assessment, 28, 917-928. doi:10.1037/pas0000232

Lee, S., Burns, G. L., & Becker, S. P. (2016). Toward establishing the transcultural validity of sluggish cognitive tempo: Evidence from a sample of South Korean children. *Journal of Clinical Child and Adolescent Psychology*. Advance online publication.

doi:10.1080/15374416.2016.1144192

Lee, S., Burns, G. L., & Becker, S. P. (2017). Can sluggish cognitive tempo be distinguished from ADHD inattention in very young children? Evidence from a sample of Korean preschool children. *Journal of Attention Disorders*, 21, 623-631.

doi:10.1177/1087054716680077

Lee, S., Burns, G. L., Snell, J., & McBurnett, K. (2014). Validity of the sluggish cognitive tempo symptom dimension in children: Sluggish cognitive tempo and ADHD-inattention as

- distinct symptom dimensions. *Journal of Abnormal Child Psychology*, 42, 7-19.
doi:10.1007/s10802-013-9714-3
- Leopold, D. R., Christopher, M. E., Burns, G. L., Becker, S. P., Olson, R. K., & Willcutt, E. G. (2016). Attention-deficit/hyperactivity disorder and sluggish cognitive tempo throughout childhood: Temporal invariance and stability from preschool through ninth grade. *Journal of Child Psychology and Psychiatry*, 57, 1066-1074. doi:10.1111/jcpp.12505
- Little, T. D. (2013). *Longitudinal structural equation modeling*. New York: Guilford.
- Marshall, S. A., Evans, S. W., Eiraldi, R. B., Becker, S. P., & Power, T. J. (2014). Social and academic impairment in youth with ADHD, predominately inattentive type and sluggish cognitive tempo. *Journal of Abnormal Child Psychology*, 42, 77-90. doi:10.1007/s10802-013-9758-4
- McBurnett, K. (2010). *Kiddie-Sluggish Cognitive Tempo Diagnostic Interview Module for Children and Adolescents*. San Francisco: Author.
- McBurnett, K., Villodas, M., Burns, G. L., Hinshaw, S. P., Beaulieu, A., & Pfiffner, L. J. (2014). Structure and validity of sluggish cognitive tempo using an expanded item pool in children with attention-deficit/hyperactivity disorder. *Journal of Abnormal Child Psychology*, 42, 37-48. doi:10.1007/s10802-013-9801-5
- Muthén, L. K., & Muthén, B. O. (1998-2014). *Mplus user's guide (7th Ed.)*. Los Angeles, CA: Muthén & Muthén.
- Penny, A. M., Waschbusch, D. A., Klein, R. M., Corkum, P., & Eskes, G. (2009). Developing a measure of sluggish cognitive tempo for children: content validity, factor structure, and reliability. *Psychological Assessment*, 21, 380-389. doi:10.1037/a0016600

- Servera, M., Bernad, M. D., Carrillo, J. M., Collado, S., & Burns, G. L. (2016). Longitudinal correlates of sluggish cognitive tempo and ADHD-inattention symptom dimensions with Spanish children. *Journal of Clinical Child and Adolescent Psychology*, 45, 632-641.
- Smith, Z. R., Becker, S. P., Garner, A. A., Rudolph, C. W., Molitor, S. J., Oddo, L. E., & Langberg, J. M. (2016). Evaluating the structure of sluggish cognitive tempo using confirmatory factor analytic and bifactor modeling with parent and youth ratings. *Assessment*. Advance online publication. doi:10.1177/1073191116653471
- Tamm, L., Brenner, S. B., Bamberger, M. E., & Becker, S. P. (2016). Are sluggish cognitive tempo symptoms associated with executive functioning in preschoolers? *Child Neuropsychology*. Advance online publication. doi:10.1080/09297049.2016.1225707
- Tamm, L., Garner, A. A., Loren, R. E., Epstein, J. N., Vaughn, A. J., Ciesielski, H. A., & Becker, S. P. (2016). Slow sluggish cognitive tempo symptoms are associated with poorer academic performance in children with ADHD. *Psychiatry Research*, 242, 251-259.
- Wåhlstedt, C., & Bohlin, G. (2010). DSM-IV-defined inattention and sluggish cognitive tempo: independent and interactive relations to neuropsychological factors and comorbidity. *Child Neuropsychology*, 16, 350-365. doi:10.1080/09297041003671176
- Watabe, Y., Owens, J. S., Evans, S. W., & Brandt, N. E. (2014). The relationship between sluggish cognitive tempo and impairment in children with and without ADHD. *Journal of Abnormal Child Psychology*, 42, 105-115. doi:10.1007/s10802-013-9767-3
- Willcutt, E. G., Chhabildas, N., Kinnear, M., DeFries, J. C., Olson, R. K., Leopold, D. R., . . . Pennington, B. F. (2014). The internal and external validity of sluggish cognitive tempo and its relation with DSM-IV ADHD. *Journal of Abnormal Child Psychology*, 42, 21-35. doi:10.1007/s10802-013-9800-6

ASSESSING SCT IN CHILDREN

Table 1

Standardized Primary and Secondary Factor Loadings

	SCT Factor	ADHD-IN Factor
Sluggish Cognitive Tempo Symptoms		
1. Behavior is slow (e.g., sluggish)	0.92*	-0.02 ^{ns}
2. Lost in a fog	0.89*	0.07*
3. Stares blankly into space	0.96*	-0.01 ^{ns}
4. Drowsy or sleepy (yawns) during the day	0.95*	-0.01 ^{ns}
5. Daydreams	0.88*	0.05 ^{ns}
6. Loses train of thought	0.86*	0.09*
7. Low level of activity (e.g., underactive)	0.97*	-0.08 ^{ns}
8. Gets lost in own thoughts	0.81*	0.12*
9. Easily tired or fatigued	1.02*	-0.09 ^{ns}
10. Forgets what was going to say	0.94*	-0.02 ^{ns}
11. Easily confused	0.91*	0.05 ^{ns}
12. Lacks motivation to complete tasks (e.g., apathetic)	0.27*	0.68*
13. Spaces or zones out	0.82*	0.13*
14. Gets mixed up	0.85*	0.11*
15. Thinking is slow	0.87*	0.06 ^{ns}
16. Difficulty expressing thoughts (e.g., gets “tongue-tied”)	0.78*	0.12*
ADHD-Inattention Symptoms		
1. Close attention	0.16*	0.78*
2. Sustaining attention	0.04 ^{ns}	0.93*
3. Listen	0.15*	0.77*
4. Follow through	0.03 ^{ns}	0.93*
5. Organization	-0.15*	1.08*
6. Avoids tasks requiring sustained effort	0.01 ^{ns}	0.93*
7. Loses things	-0.15*	1.08*
8. Easily distracted	-0.02 ^{ns}	0.95*
9. Forgetful	0.13*	0.82*

Note. Each symptom was rated on a 6-point scale. The full *Child and Adolescent Behavior Inventory* (CABI) measure is available from the corresponding author. Partial standardized regression coefficients can be larger than one with cross-loadings and correlated factors. ADHD = attention-deficit/hyperactivity disorder. ADHD-IN = attention-deficit hyperactivity disorder inattention. SCT = sluggish cognitive tempo. * $p < .05$; ^{ns} = non-significant.

Table 2

Measure (Manifest Variables) Descriptive Statistics

	Girls			Boys			<i>d</i>
	<i>M</i>	<i>SD</i>	Range	<i>M</i>	<i>SD</i>	Range	
Sluggish Cognitive Tempo	0.70 ^a	1.02	0 to 5	1.04 ^b	1.30	0 to 5	.29
ADHD-Inattention	0.78 ^a	1.18	0 to 5	1.36 ^b	1.53	0 to 5	.42
Social Impairment	2.10 ^a	1.34	0 to 5.5	2.48 ^b	1.44	0 to 6	.27
Academic Impairment	2.24 ^a	1.63	0 to 6	2.72 ^b	1.80	0 to 6	.18

Note. Sluggish cognitive tempo and ADHD-inattention were rated on a 0 to 5 scale whereas social and academic impairment were rated on a 0 to 6 scale. Row means with different superscripts differ a $p < .01$. Higher scores represent greater symptom occurrence and higher levels of impairment. ADHD = attention-deficit hyperactivity disorder; d = Cohen's d for manifest variable means.